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(54) **HYDRO ENERGY-OFFSET TURBINE INSERT GENERATOR**


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(22) Filed: **Apr. 12, 2013**

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(51) **Int. Cl.**
***F03B 13/00*** (2006.01)
***F03B 13/10*** (2006.01)
***H02P 9/04*** (2006.01)

(52) **U.S. Cl.**
CPC ..................................... ***F03B 13/10*** (2013.01)

(58) **Field of Classification Search**
CPC ...................................................... F03B 13/10
USPC ......................................... 290/43, 42, 53, 54
See application file for complete search history.


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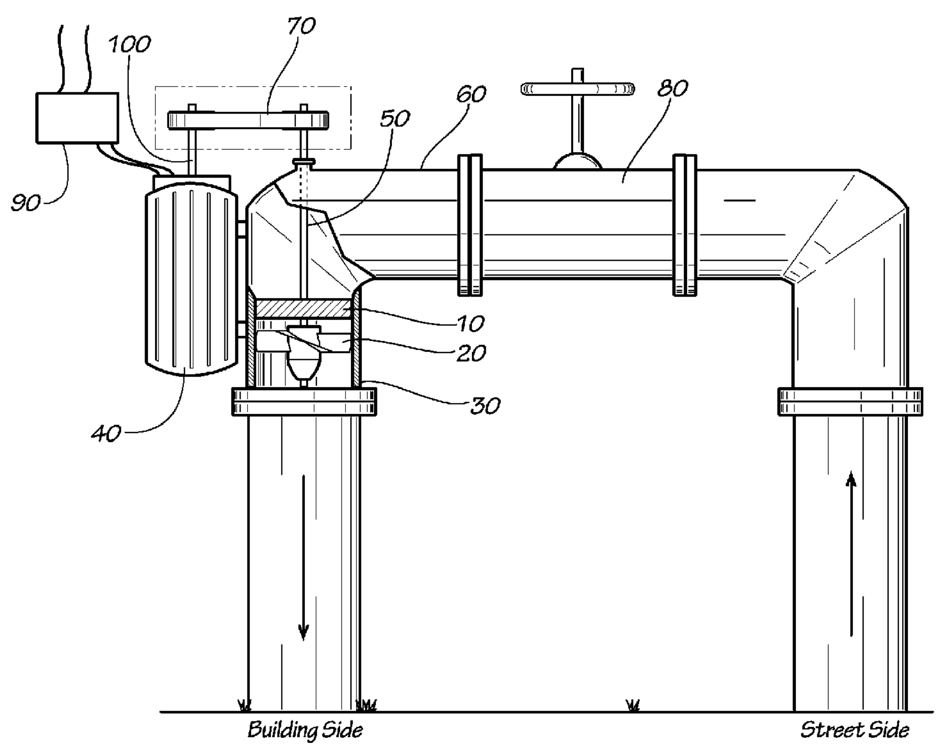
(57) **ABSTRACT**


The present disclosure describes a hydro energy-offset turbine insert generator to generate energy within a piping system. The system can include a fluid conduit that includes an inner wall structure and a pipe sleeve disposed along the inner wall structure to reduce the cross-sectional area of the interior of the conduit. The system can also include a turbine positioned within the fluid conduit adjacent the pipe sleeve and a flow diverter upstream of the turbine. A drive shaft is coupled to the turbine and extends to an area outside of the fluid conduit. The drive shaft can be directly or indirectly coupled to a generator or multiple generators positioned in the area outside of the fluid conduit. Fluid passing through the conduct can cause a rotational action in the turbine that causes a corresponding rotation in the drive shaft and generator to generate electricity.


**20 Claims, 7 Drawing Sheets**



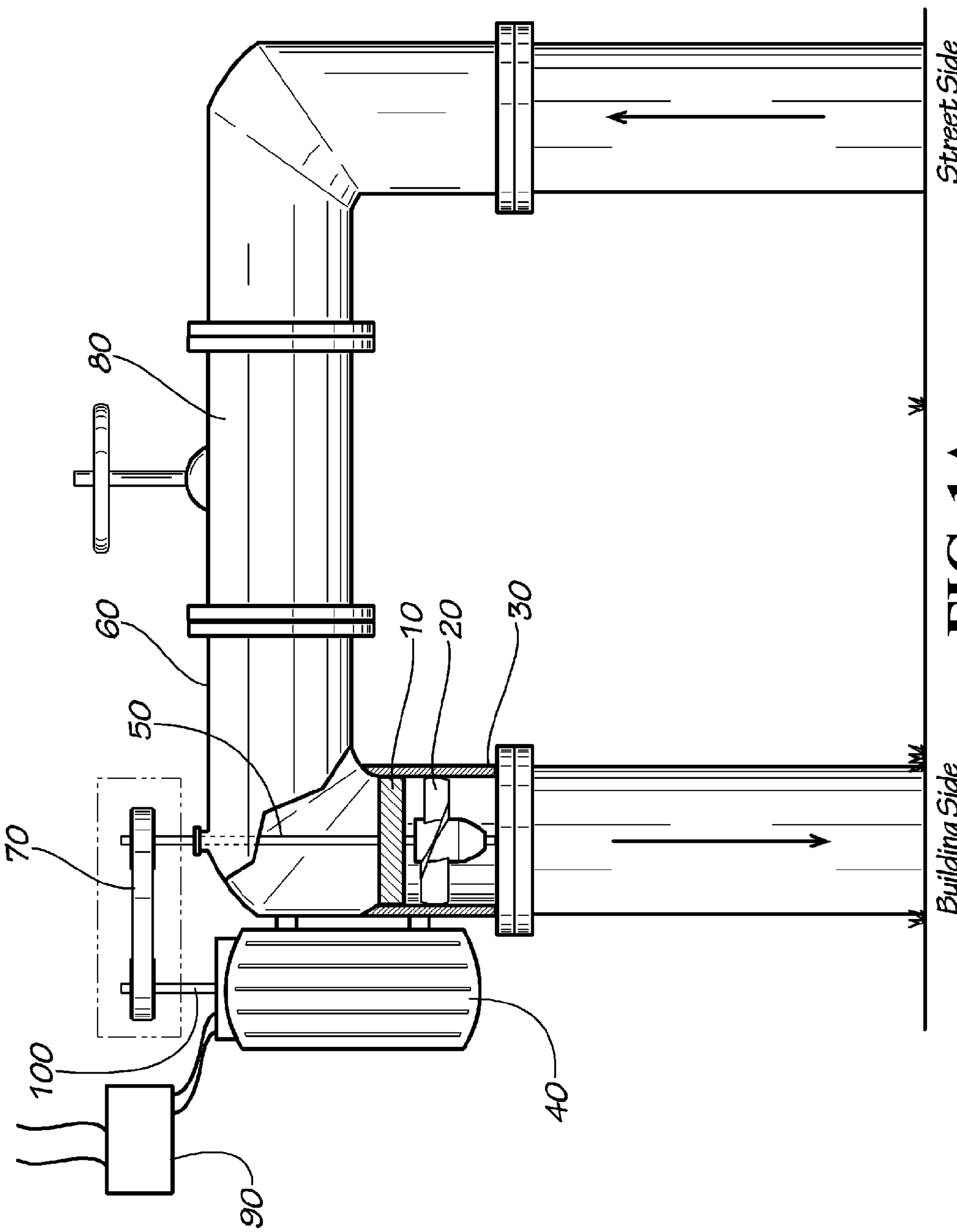



FIG. 1A

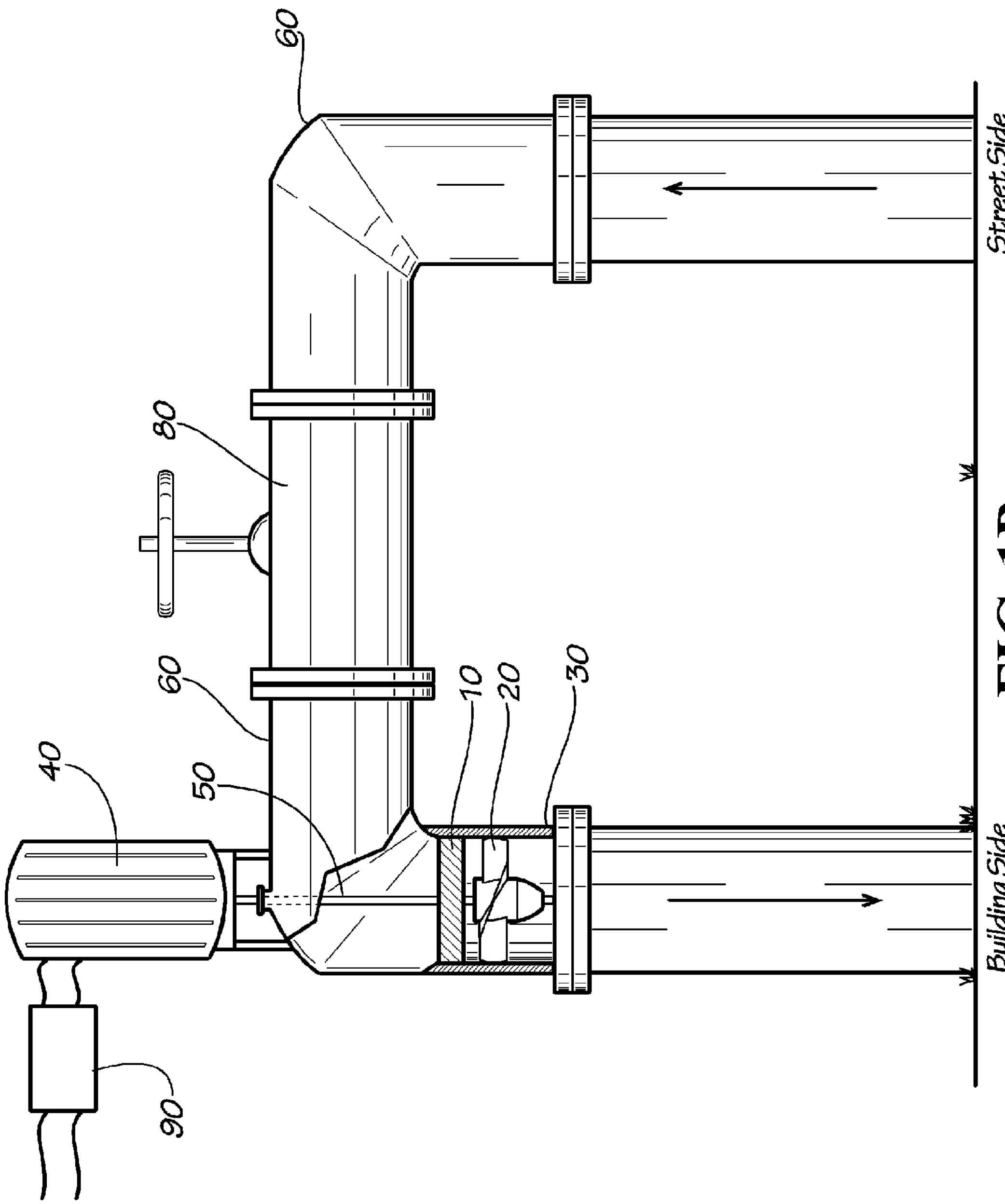



FIG. 1B

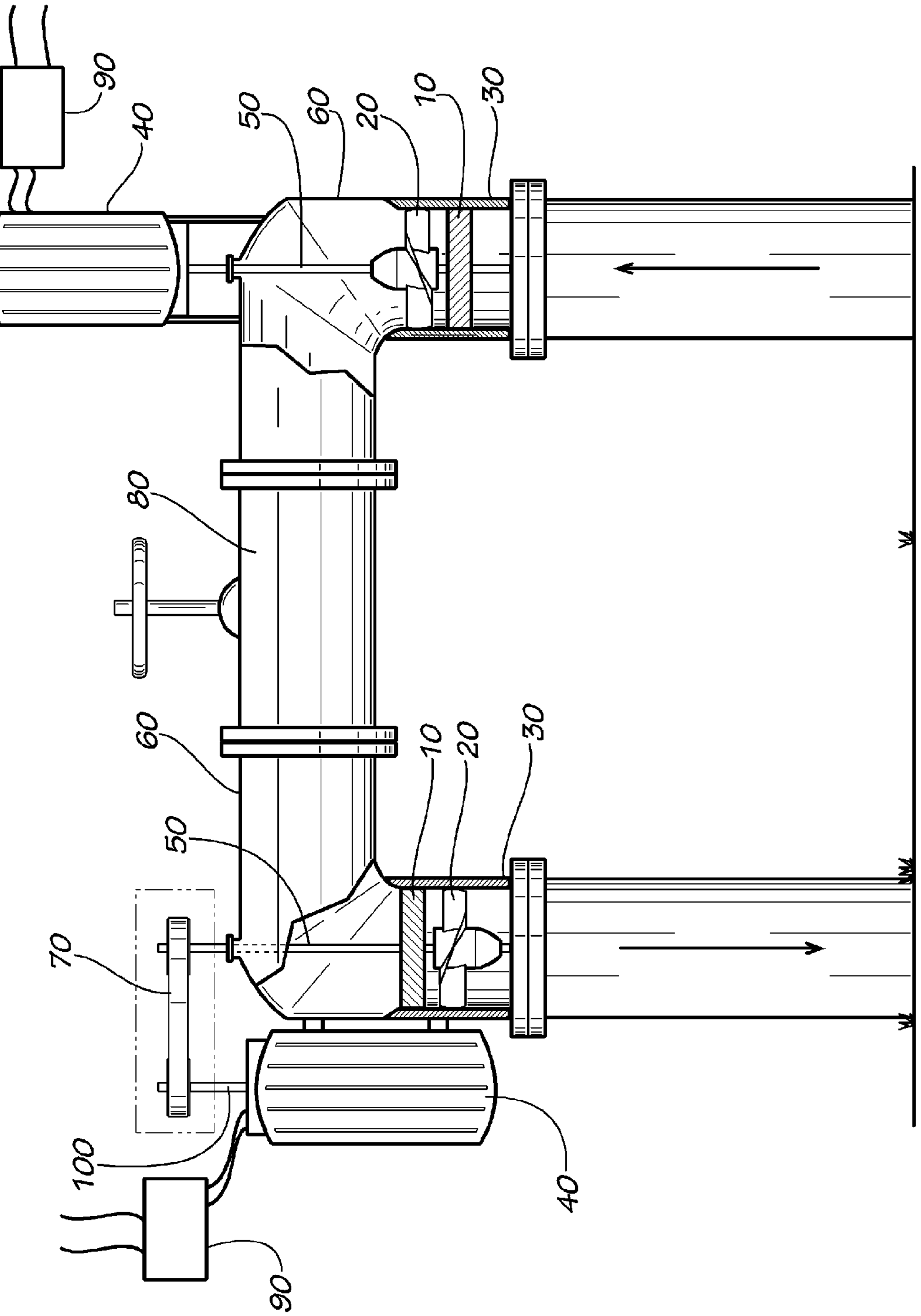



FIG. 1C

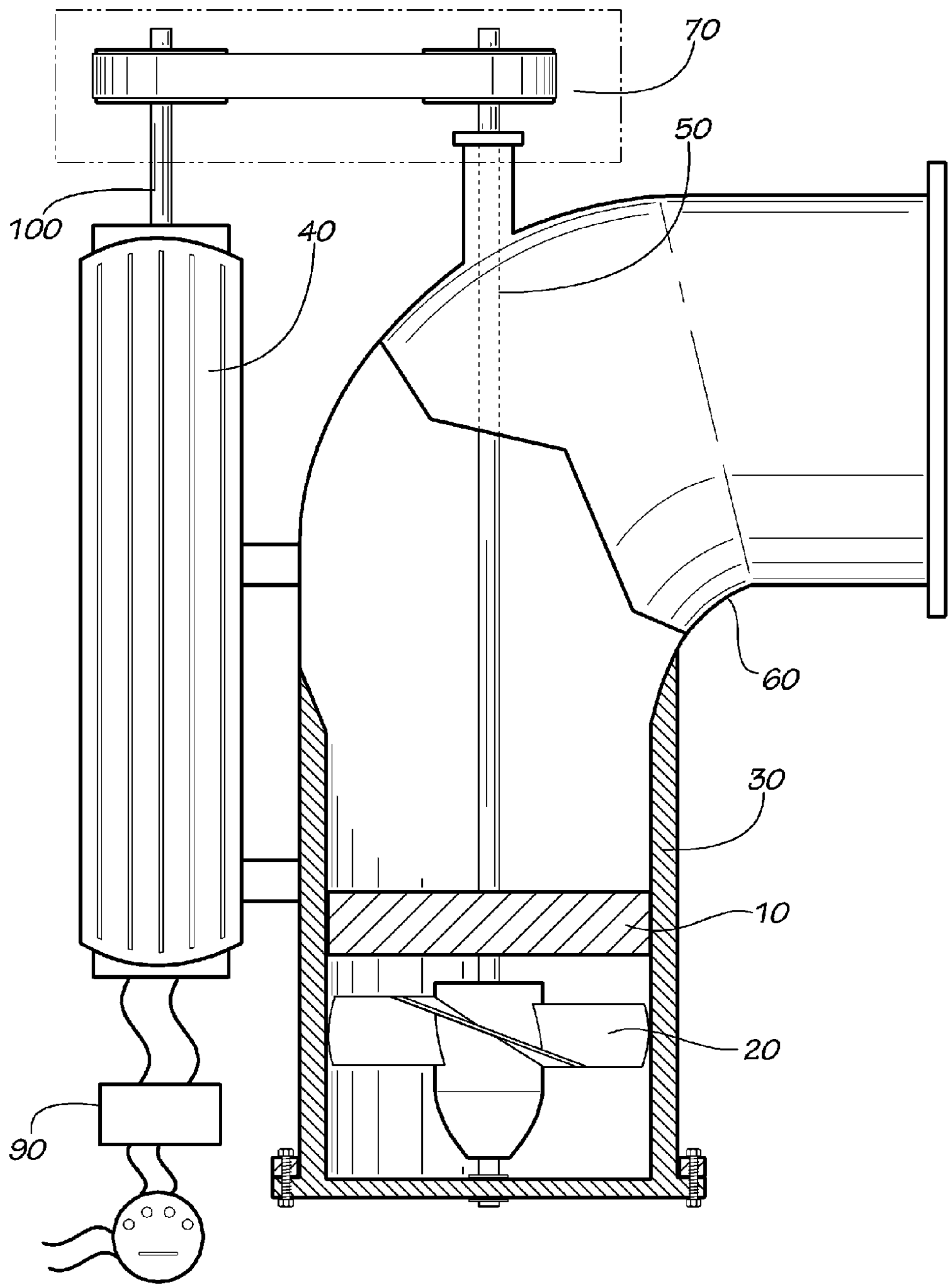



FIG. 2A

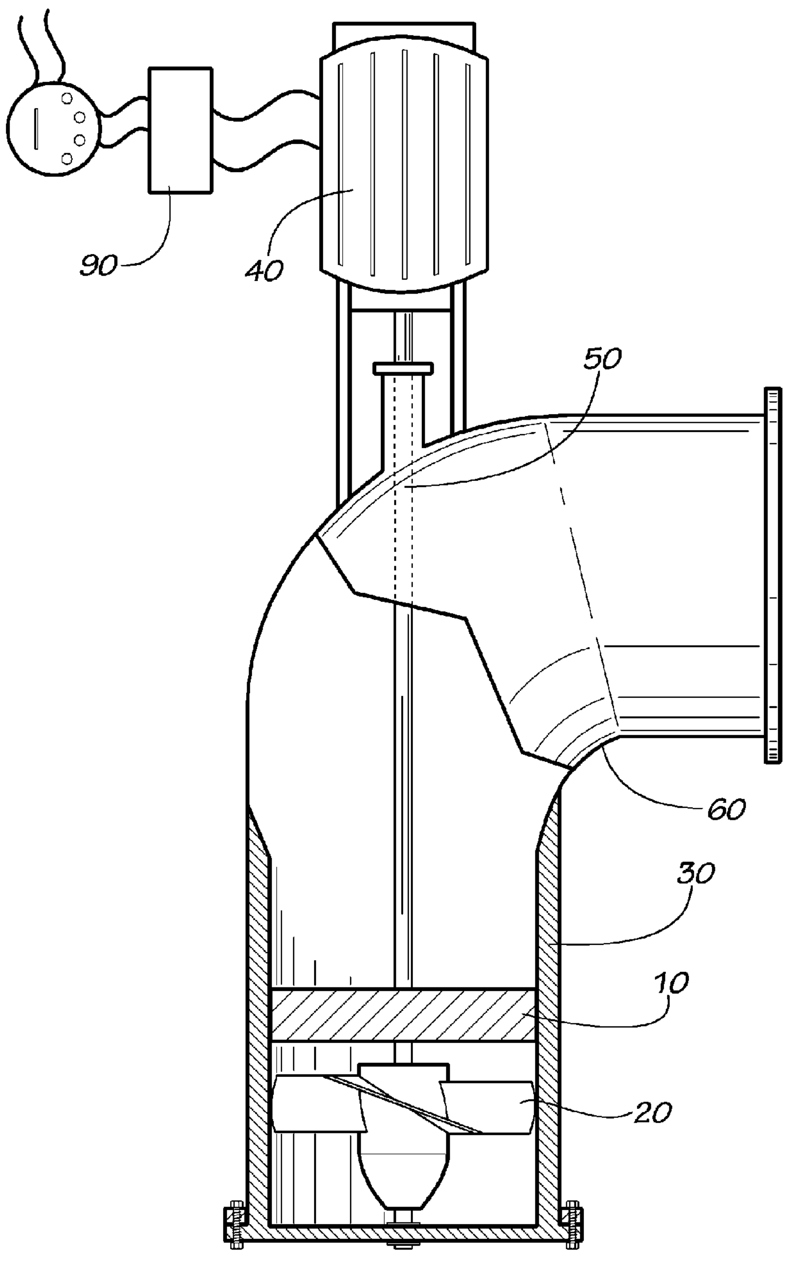



FIG. 2B

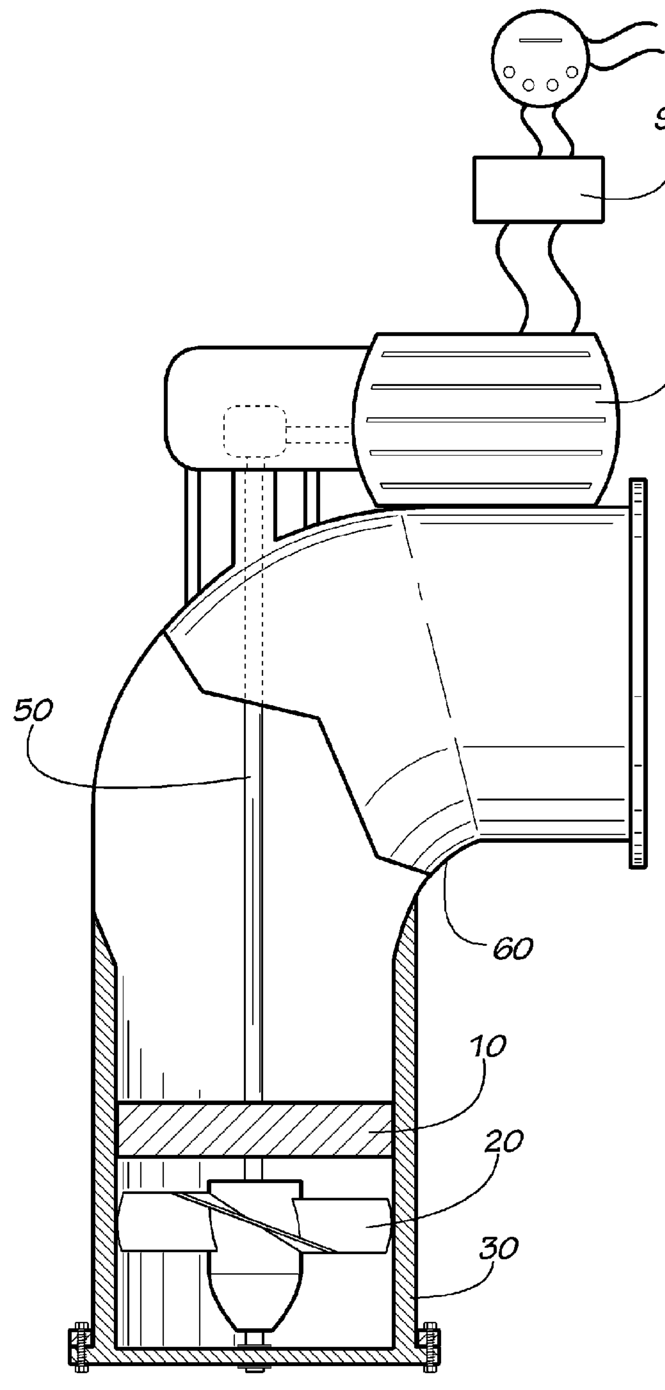



FIG. 2C

FIG. 3

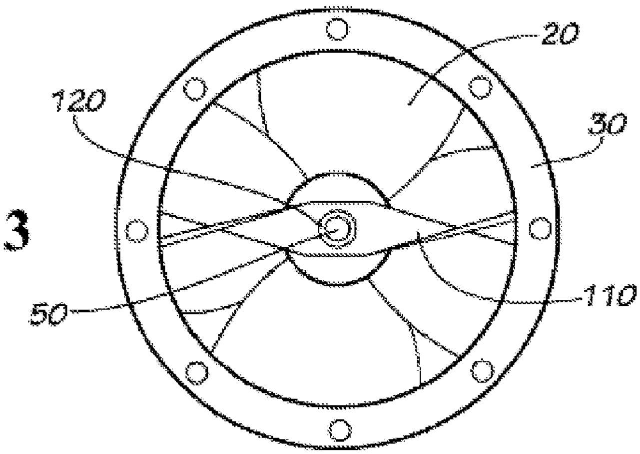



FIG. 4

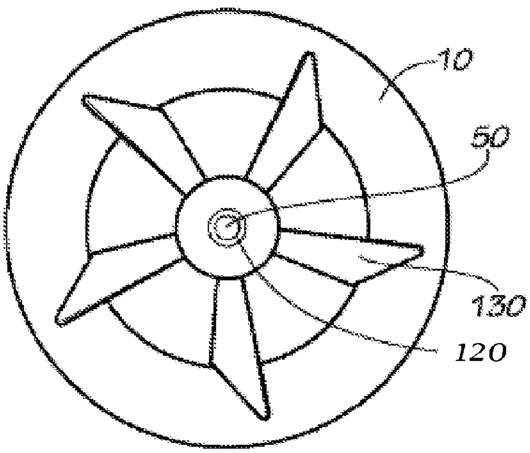
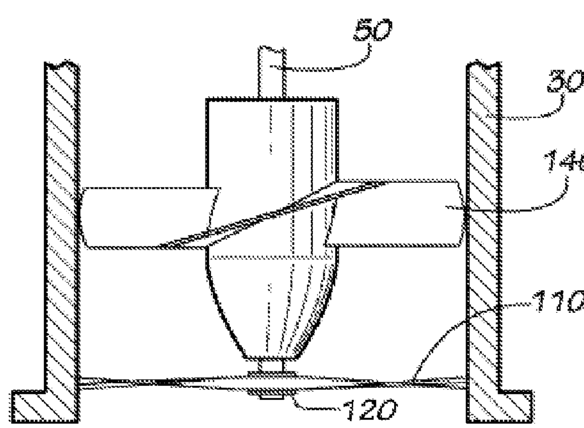



FIG. 5



# HYDRO ENERGY-OFFSET TURBINE INSERT GENERATOR

## RELATED APPLICATION

This application claims priority under 35 U.S.C. §119(e) to U.S. Provisional Patent Application No. 61/623,953, titled Hydro Energy-Offset Turbine Insert Generator, filed on Apr. 13, 2012, the entire contents of which are hereby incorporated herein by reference.

## TECHNICAL FIELD

Aspects of the disclosure relate generally to fluid power generation, and more particularly, to systems and methods for fluid power generation with an energy-offset turbine insert generator in a fluid conduit.

## BACKGROUND

Presently, regional energy grids are aging and are challenged to keep up with peak energy demands. Additionally, electrical utility rates have been known to substantially rise during peak usage hours resulting in increased expense and operating costs.

Some efforts have been undertaken to supplement or reduce reliance on the energy grid by harnessing "green" power. These efforts include employing arrays of solar power cells and wind farms. However, such efforts require additional real estate and space that may not be available. These space restrictions are an even greater issue in large metropolitan areas, where such space is at a premium. Additionally, these efforts do not take advantage of untapped sources of energy generation that may be implemented within the framework of existing infrastructure.

## SUMMARY

Example embodiments of the present disclosure provide systems of a hydro energy-offset turbine generator. Briefly described, in architecture, one example embodiment of the system, among others, can include a turbine disposed in a fluid carrying conduit. The system can also include a drive shaft having a first end and a distal second end. The drive shaft can be coupled to the turbine between the first end and the second end and can be configured to rotationally drive the drive shaft. The second end of the drive shaft can extend to an area outside the conduit. A generator can be positioned outside the conduit and coupled to the drive shaft at or near the second end. The generator can generate electrical power in response to the rotational drive of the drive shaft by the turbine.

In accordance with another example embodiment of the present disclosure, a hydro energy system is provided that can include a turbine configured to be disposed in a fluid carrying conduit. The fluid carrying conduct can include a pipe elbow. A flow diverter can be positioned in the conduit upstream of the turbine. A drive shaft can be coupled to and rotationally driven by the turbine. The drive shaft can include a first portion coupled to the turbine and a distal second portion extending outside of the conduit. A generator can be positioned outside of the conduit and operatively coupled to the drive shaft. The generator can generate electrical power in response to the rotational drive of the drive shaft by the turbine.

In accordance with yet another example embodiment of the present disclosure, a hydro energy system is provided that can include a fluid carrying conduit. The conduit can have an inner wall defining a fluid passageway through the conduct that has a cross-sectional area. The system can also include a turbine disposed in the fluid carrying conduit and a reducing sleeve coupled to the fluid carrying conduit and disposed along an inner wall of the fluid carrying conduit proximate the turbine. The reducing sleeve can reduce the cross-sectional area of the fluid passageway. The system can also include a drive shaft having a first portion and a distal second portion. The first portion of the drive shaft can be coupled to and rotationally driven by the turbine. The second portion of the drive shaft can extend from the first portion to an area outside the conduit. The system can also include a generator positioned outside the conduit and operatively connected to the drive shaft. The generator can generate electrical power in response to the rotational drive of the drive shaft by the turbine.

There has thus been outlined, rather broadly, certain embodiments of the disclosure in order that the detailed description thereof herein may be better understood, and in order that the present contribution to the art may be better appreciated. There are, of course, additional embodiments that will be described below and which will form the subject matter of the claims appended hereto.



## BRIEF DESCRIPTION OF THE DRAWINGS

The present disclosure is best understood from the following detailed description when read with the accompanying figures. It is emphasized that, in accordance with the standard practice in the industry, various features are not drawn to scale. In fact, the dimensions of the various features may be arbitrarily increased or reduced for clarity of discussion.

FIG. **1**A illustrates a side elevation view, partially in cross-section, of a hydro energy apparatus illustrated with a belt drive transmission generator configuration in accordance with one example embodiment of the present disclosure.

FIG. **1**B illustrates a side elevation view, partially in cross-section, of a hydro energy apparatus illustrated with a direct drive generator configuration in accordance with another example embodiment of the present disclosure.

FIG. **1**C illustrates a side elevation view, partially in cross-section, of a hydro energy apparatus with a belt driven and direct drive generator configuration utilizing both pipe elbows within the system in accordance with another example embodiment of the present disclosure.

FIG. **2**A illustrates a detailed cross-section view of the example hydro energy apparatus shown in FIG. **1**A.

FIG. **2**B illustrates a detailed cross-section view of the example hydro energy apparatus shown in FIG. **1**B.

FIG. **2**C illustrates a detailed cross-section view of the hydro energy apparatus utilizing a transmission drive generator in accordance with one example embodiment of the present disclosure.

FIG. **3** illustrates a front view of the example reduction sleeve and turbine assembly of FIG. **1**A.

FIG. **4** illustrates a front view of the example wicket gate flow diverter of FIG. **1**A.

FIG. **5** illustrates a side view of the example turbine of FIG. **1**A shown within a partial cross-sectional view of the reducing sleeve.

## DETAILED DESCRIPTION OF THE EXAMPLE EMBODIMENTS

It is to be understood that the following disclosure provides many different embodiments, or examples, for implementing different features of various embodiments. Specific examples of components and arrangements are described below to simplify the present disclosure. These are, of course, merely examples and are not intended to be limiting. In addition, the present disclosure may repeat reference numerals and/or letters in the various examples. This repetition is for the purpose of simplicity and clarity and does not in itself dictate a relationship between the various embodiments and/or configurations discussed. Moreover, the formation of a first feature over or on a second feature in the description that follows may include embodiments in which the first and second features are formed in direct contact, and may also include embodiments in which additional features may be formed interposing the first and second features, such that the first and second features may not be in direct contact.

In the following description, numerous details are set forth to provide an understanding of the present disclosure. However, it will be understood by those of ordinary skill in the art that the present disclosure may be practiced without these details and that numerous variations or modifications from the described embodiments may be possible. The disclosure will now be described with reference to the figures, in which like reference numerals refer to like, but not necessarily the same or identical, elements throughout. For purposes of clarity in illustrating the characteristics of the present disclosure, proportional relationships of the elements have not necessarily been maintained in the figures.

According to one example embodiment of the disclosure, a hydro energy apparatus can include a hydroelectric Kaplan turbine generator, one or more fixed wicket gate vanes, and one or more fixed turbine blades. In operation, the turbine blades rotate along an axis to produce offset electricity from one or more generators based on the velocity and volume of fluid flowing through the piping system, while maintaining a majority of the fluid flow and pressure within the piping system utilized. In one exemplary embodiment, the piping system can be a public water supply system that provides water for human consumption. For example, the hydro energy apparatus can be positioned between the main line of a public water supply system (e.g. a metropolitan, city, rural or cooperative water supply system) and the structure (e.g. office building, apartment building/complex, condominium, house, mall, shopping center, etc.) that is receiving the water, such as within a branch line that branches off of a main or primary water supply line that provides a water pathway to multiple structures. As such, multiple hydro energy apparatuses can be positioned within the multiple branch lines that branch off of a main or primary supply line for the public water supply system and provide water to a particular structure or structures. The terms Hydro Energy-Offset turbine generator, hydro energy apparatus, and hydro energy device may be used interchangeably throughout the disclosure.

The Hydro Energy-Offset turbine generator may be configured in several embodiments, including, but not limited to those example embodiments shown in FIGS. **1**A-C. The configuration differences between the example embodiments may be based, for example, on whether a generator **40**, is belt/transmission **70** driven or directly driven by the turbine drive shaft **50**. Also, configuration differences may be determined by the direction of the fluid flow and the location of the pipe elbow **60**. One such configuration difference may include the positioning or location of the wicket gate flow diverter **10** and the turbine **20** (as depicted in FIG. **1**C) in order to incorporate a hydro energy device upstream of the backflow preventer **80**.

FIG. **1**A illustrates a side elevation view, in partial cross-section, of a hydro energy apparatus in a transmission/belt drive configuration connected within a backflow preventer piping system **80** above the ground in accordance with an example embodiment of the disclosure. Though shown above ground, the hydro energy apparatus could be positioned below ground or below grade in accordance with another example embodiment of the current disclosure. Referring now to FIG. **1**A, the directional flow of the water or fluid within the piping system is from the "street" side to the "building" side and runs through the backflow preventer **80**. One of the pipe elbows **60** is positioned downstream of the backflow preventer **80** and includes or is disposed adjacent to components of the exemplary hydro energy device.

The example pipe elbow **60** can include therein a reducing sleeve **30**, a turbine **20**, a wicket gate flow diverter **10**, and a drive shaft **50**. In one example embodiment, the wicket gate flow diverter **10** is disposed within the pipe elbow **60** upstream from the turbine **20**. The exemplary flow diverter **10** can help get the water or other fluid flowing in a direction and manner that will enhance the effect of the water or fluid on the turbine **20** to create an improved output as compared to a system without the diverter **10**. Further, the example reducing sleeve **30** can be disposed adjacent the inner wall of the pipe elbow **60** for all or a portion of the flow length of the pipe elbow **60** to reduce the effective inner diameter of the pipe elbow **60**. In addition, the example drive shaft **50** can include a first end, an intermediate portion, and a distal second end. The first end of the drive shaft **50** can be coupled to the turbine **20**, either directly or indirectly, the intermediate portion can extend from the first end through at least a portion of the interior of the pipe elbow **60** and through the wall of the pipe elbow **60** to the second distal end of the drive shaft **50**, which can be coupled, either directly or indirectly, to a belt drive system **70**. Additionally, as shown in FIGS. **3** and **5**, the reducing sleeve **30** may also include a reducing sleeve cross brace **110** and bearing **120**. The bearing can be seated in an opening or channel passing through the cross brace **110** and receives a portion of the first end of the drive shaft **50** therethrough.

The example system can also include a control/monitoring unit **90** communicably coupled to the generator **40**. In addition, the belt drive system **70** can be coupled to the generator **40** via the generator drive shaft **100**. With variable, yet steady gallons per minute (GPM) and pound-force per square inch (PSI), the combination of flow and pressure of the fluid within the piping system, along with a reduction in pipe diameter in at least a portion of the pipe elbow **60**, due to the reducing sleeve **30**, causes the water or fluid within the piping system to engage the turbine **20** causing it to rotate and causing a corresponding rotation of the drive shaft **50**. The rotational energy of the drive shaft **50** is transferred to the generator drive shaft **100** by way of the belt drive system **70**, which engages the generator **40** to generate the desired offset-energy. The fluid then continues to flow toward the "building" side to its final destination.

FIG. **1**B illustrates a side elevation view, in partial cross-section, of another example embodiment of a hydro energy apparatus in direct drive configuration as it is connected within the backflow preventer piping system **80** above the ground (new or existing). Though shown above ground, in alternative embodiments, the hydro energy apparatus could be positioned below ground or below grade in accordance with another example embodiment of the current disclosure. Referring now to FIG. **1**B, similar to FIG. **1**A, the directional flow of the water/fluid is from the street side to the building side and runs through the backflow preventer **80**. The piping system also includes a pipe elbow **60** positioned downstream of the backflow preventer **80**. In this example embodiment, the pipe elbow **60** includes some of the components of the hydro energy device. For example, the pipe elbow **60** can include therein a reducing sleeve **30**, a turbine **20**, a wicket gate flow diverter **10**, and at least a portion of the drive shaft **50**.

In one example the sleeve **30**, turbine **20** and wicket gate flow diverter **10** are substantially the same as and positioned substantially the same as that described above in FIG. **1**A and will not be repeated for the sake of brevity. The example drive shaft **50** can include a first end, an intermediate portion, and a distal second end. The first end of the drive shaft **50** can be coupled to the turbine **20**, either directly or indirectly, the intermediate portion can extend from the first end through at least a portion of the interior of the pipe elbow **60** and through the wall of the pipe elbow **60** to a second distal end of the drive shaft **50**, which can be coupled, either directly or indirectly, to the generator **40**. In addition, the generator **40** can also include a support for the generator **40** in a direct drive configuration. In one example, the support can be coupled along one portion to the piping system, such as the pipe elbow **60**, and have another portion coupled to the generator **40**. As shown in FIGS. **3** and **5**, the reducing sleeve **30** can also include a reducing sleeve cross brace **110** and bearing **120**. The bearing can be seated in an opening or channel passing through the cross brace **110** and receives a portion of the first end of the drive shaft **50** therethrough.

The example system can also include a control/monitoring unit **90** communicably coupled to the generator **40**. In one example embodiment, the control/monitoring unit **90** is configured to regulate the electrical power generated by the generator **40**, provide for remote monitoring of the generator **40**, provide a mechanism for emergency shut off of the generator **40** and/or other monitoring or control functions that may be desired. With variable, yet steady gallons per minute (GPM) and pound-force per square inch (PSI), the combination of flow and pressure of the water/fluid within the piping system, along with the reduction in pipe diameter in at least a portion of the pipe elbow **60** due to the inclusion of the reducing sleeve **30**, causes the water/fluid within the piping system to engage the turbine **20** causing it to rotate and causing a corresponding rotation of the turbine drive shaft **50**. The rotational energy of the turbine drive shaft **50** is transferred to the generator **40**, where coupled, to generate the desired offset-energy. The fluid will then continue flowing through the piping system toward the building side to its final destination.

FIG. **1**C shows a side elevation view, in partial cross-section, of another example embodiment of a hydro energy apparatus connected within both sides of the backflow preventer piping system **80** above the ground. Though shown above ground, the hydro energy apparatus could be underground in accordance with another example embodiment of the current disclosure. Referring now to FIG. **1**C, the directional flow of the water or fluid within the piping system is from the "street" side to the "building" side and runs through the backflow preventer **80**. One of the pipe elbows **60** is positioned downstream of the backflow preventer **80** and includes or is disposed adjacent to components of the exemplary hydro energy device. Additionally, one of the pipe elbows **60** is positioned upstream of the backflow preventer **80** and includes or is disposed adjacent to components of the exemplary hydro energy device.

The example pipe elbow **60**, downstream of the backflow preventer **80** can include therein, a reducing sleeve **30**, a turbine **20**, a wicket gate flow diverter **10**, and a drive shaft **50**. In addition, the generator **40** also includes a belt drive system **70**, and a control/monitoring unit **90**. Further, the example reducing sleeve **30** can be disposed adjacent the inner wall of the downstream pipe elbow **60** for all or a portion of the flow length of the pipe elbow **60** to reduce the effective inner diameter of the pipe elbow **60**. In addition, the example drive shaft **50** can include a first end, an intermediate portion, and a distal second end. The first end of the drive shaft **50** can be coupled to the turbine **20**, either directly or indirectly, the intermediate portion can extend from the first end through at least a portion of the interior of the pipe elbow **60** and through the wall of the pipe elbow **60** to the second distal end of the drive shaft **50**, which can be coupled, either directly or indirectly, to a belt drive system **70**.

The example pipe elbow **60** upstream of the backflow preventer **80** can include therein, a reducing sleeve **30**, a turbine **20**, a wicket gate flow diverter **10**, and a drive shaft **50**. As shown, due to the location of the upstream pipe elbow **60**, wicket gate flow diverter **10** is positioned towards the front portion of the drive shaft **50** due to the fluid directional flow. In addition, the generator **40** also includes a belt drive system **70**, and a control/monitoring unit **90**. Further, the example reducing sleeve **30** can be disposed adjacent the inner wall of the downstream pipe elbow **60** for all or a portion of the flow length of the pipe elbow **60** to reduce the effective inner diameter of the pipe elbow **60**. In addition, the example drive shaft **50** can include a first end, an intermediate portion, and a distal second end. The first end of the drive shaft **50** can be coupled to the turbine **20**, either directly or indirectly, the intermediate portion can extend from the first end through at least a portion of the interior of the pipe elbow **60** and through the wall of the pipe elbow **60** to the second distal end of the drive shaft **50**, which can be coupled, either directly or indirectly, to a belt drive system **70**.

With a variable, yet steady gallons per minute (GPM) and pound-force per square inch (PSI), the combination of flow and pressure, along with the reduction in pipe diameter due to the reducing sleeve **30**, cause the turbine **20** to engage and rotate the drive shaft **50** to engage the generator **40** to create the desired offset-energy. The fluid then continues flowing toward the "building" side.

Additionally, as shown in FIGS. **3** and **5**, the reducing sleeve **30** may also include a reducing sleeve cross brace **110** and bearing **120**. The bearing can be seated in an opening or channel that passes through a portion of the cross brace **110** and the bearing receives a portion of the first end of the drive shaft **50** therethrough.

FIG. **2**A illustrates a detailed cross-sectional view of the pipe elbow **60** with the components of one example embodiment of the hydro energy-offset turbine generator system, as shown in FIG. **1**A. Now referring to FIGS. **1**A and **2**A, the exemplary reducing sleeve **30** serves to stabilize the drive shaft **50**, as further described in FIGS. **3** and **5**, and provide a reduction in the inner cross-sectional area of the pipe elbow **60**. In one example, an inner diameter of the pipe elbow **60** with the reducing sleeve **30** is reduced by 0-6 inches as compared to the inner diameter of the pipe elbow **60** alone. The reduction of the inner cross-sectional area of the combined elbow **60** and sleeve **30** is typically achieved prior to the water/fluid attaining the position of the wicket gate diverter **10**. The wicket gate diverter **10** then further isolates and purposefully directs the flow of the water/fluid toward the turbine **20**. As the water/fluid flows through the sleeved portion of the pipe corner **60** and causes the turbine **20** to rotate. The rotation of the turbine **20** causes a corresponding rotation in the drive shaft **50**, which is coupled to the turbine **20**. The belt drive system **70** is engaged and revolves as it is driven by the rotation of the turbine drive shaft **50**. The belt drive system **70** transfers the rotational energy of the turbine drive shaft **50** to the generator **40** by causing a geared or corresponding rotation in the shaft **100** of the generator **40**, thereby generating offset electricity that may then be fed back into the grid through a control unit device **90**. Alternatively, the energy generated by the generator **40** may be utilized in other ways, such as feeding a storage bank of batteries.

FIG. **2**B depicts a cross-sectional view of the pipe elbow **60** with components that comprise the hydro energy-offset turbine generator device as shown in FIG. **1**B. Now referring to FIGS. **1**B and **2**B, the exemplary reducing sleeve **30** serves to stabilize the drive shaft **50** as further described in FIGS. **3** and **5**. Reducing sleeve **30** provides a reduction in the pipe elbow **60**, for example, by 1-6 inches as compared with the inner diameter of the pipe elbow **60** alone. The reduction of the inner cross-sectional area of the combined elbow **60** and sleeve **30** is typically achieved prior to the water/fluid attaining the position of the wicket gate diverter **10**. The wicket gate diverter **10** then further isolates and purposefully directs the flow of the water/fluid toward the turbine **20**. As the water/fluid flows through the sleeved portion of the pipe corner **60** and causes the turbine **20** to rotate. The rotation of the turbine **20** causes a corresponding rotation in the drive shaft **50**, which is coupled to the turbine **20**. The rotational energy of the turbine drive shaft **50** is transferred to the generator **40**, where coupled, thereby generating offset electricity that may then be fed back into the grid through a control unit device **90**. Alternatively, the energy generated by the generator **40** may be utilized in other ways, such as feeding a storage bank of batteries.

FIG. **2**C depicts a detailed cross sectional view of the pipe elbow **60** with the components that comprise the hydro energy-offset turbine generator device as shown in utilizing a right angle transmission configuration. Now referring to FIG. **2**C, the exemplary reducing sleeve **30** serves to stabilize the drive shaft **50**, as further described in FIGS. **3** and **5**, and provide a reduction in the inner cross-sectional area of the pipe elbow **60**. In one example, an inner diameter of the pipe elbow **60** with the reducing sleeve **30** is reduced by 0-6 inches as compared to the inner diameter of the pipe elbow **60** alone. The reduction of the inner cross-sectional area of the combined elbow **60** and sleeve **30** is typically achieved prior to the water/fluid attaining the position of the wicket gate diverter **10**. The wicket gate diverter **10** then further isolates and purposefully directs the flow of the water/fluid toward the turbine **20**. As the water/fluid flows through the sleeved portion of the pipe corner **60** and causes the turbine **20** to rotate. The rotation of the turbine **20** causes a corresponding rotation in the drive shaft **50**, which is coupled to the turbine **20**. The belt drive system **70** transfers the rotational energy of the turbine drive shaft **50** to the generator **40** by causing a geared or corresponding rotation in the shaft **100** of the generator **40**, thereby generating offset electricity that may then be fed back into the grid through a control unit device **90**. The right angle transmission system **70** transfers the rotational energy of the turbine drive shaft **50** to the generator **40** by causing a geared or corresponding rotation in the shaft **100** of the generator **40**, thereby generating offset electricity that may then be fed back into the grid through a control unit device **90**, or utilized in other ways, such as feeding a storage bank of batteries.

FIG. **3** illustrates a front view through the outflow end portion of the pipe elbow **60** of the example reduction sleeve and turbine assembly of FIG. **1**A in accordance with an example embodiment of the disclosure. Referring now to FIG. **3**, in certain exemplary embodiments, the reducing sleeve **30** houses and secures some of the components of the turbine **20**. As shown, the reducing sleeve **30** includes a cross brace **110** that can be, for example, welded to opposing sides of the reducing sleeve **30**. The cross brace **110** can include an opening or channel therethrough that houses a bearing **120**. The bearing **120** includes a channel that receives a portion of the first end of the turbine drive shaft **50** therethrough. As shown, in one example embodiment, the reducing sleeve cross brace **110** is twisted to allow for minimal flow reduction and disturbance as the water/fluid exits the hydro energy-offset turbine generator system. The drive shaft **50** extends through the turbine **20** and out of the pipe elbow **60**, where the second end of the drive shaft **50** is coupled to the belt drive system **70**.

In certain example embodiments, the reducing sleeve **30** can serve multiple purposes. One purpose can be to reduce the diameter and/or cross-sectional area of the pipe, which causes a type of Venturi effect, where the velocity of the water/fluid increases as the cross-sectional area decreases. Additionally, the reducing sleeve **30** can serve to stabilize internal components of the energy-offset unit inside the pipe elbow **60**. The exemplary wicket gate flow diverter **10** is coupled, for example on opposing ends, to the reducing sleeve **30**. As shown, one or more bearings **120** are incorporated into the wicket gate flow diverter **10** and the reducing sleeve cross brace **110**. This arrangement of bearings **120** on opposite sides of the turbine **20** can help maintain the position of the generator drive shaft **50** and reduce possible wobble in the drive shaft **50** due to the variations in flow and pressure of the water/fluid. Additionally, the reducing sleeve **30** facilitates maintenance in the event that a system component requires adjustment or replacement. For example, in one embodiment, the turbine **20** and flow diverter **10** may be directly or indirectly coupled to the sleeve **30** such that removal of the sleeve **30** from the pipe elbow **60** will also remove the turbine **20** and flow diverter **10**. Furthermore, the sleeve **30** can have irregular thickness or shape at different points around its circumference to provide adjustability with respect to an irregularly-shaped pipe elbow **60** to provide a substantially constant diameter once the sleeve **30** is positioned within the pipe elbow **60**.

FIG. **4** illustrates a front view of a wicket gate flow diverter **10** with a plurality of fixed wicket gate vanes **130** in accordance with an example embodiment of the disclosure. Now referring to FIG. **4**, the drive shaft **50** protrudes through the center of the wicket gate flow diverter **10** with bearings **120** at the front and rear of the wicket gate flow diverter **10** in one example embodiment. One or more wicket gate vanes **130** extend radially or substantially radially outward from a central hub or center of the wicket gate flow diverter **10**. Each vane **130** can be angularly disposed at any angle between 0-90 degrees with regard to the general direction of fluid flow in the pipe elbow **60**. The particular angle of each vane **130** can be configurable based on the particular aspects of the pipe system in which the device is installed. In one exemplary embodiment, the angle for the vanes **130** is determined based, at least in part, on the flow rate and PSI pressure of the water or other fluid within the pipe elbow **60**. Furthermore, while the example of FIG. **4** shows five fixed vanes **130**, any number of vanes, greater or lesser than five, may be provided based on the particular operational aspects of the system being configured.

FIG. **5** illustrates a side view of a turbine **20** of the hydro energy system in accordance with an example embodiment of the disclosure. Referring to FIG. **5**, the turbine **20** is coupled to the drive shaft **50** adjacent to the first end of the drive shaft **50**. According to some example embodiments of the disclosure, the first end of the drive shaft **50** is movably coupled to a bearing **120** that is seated in the opening or channel of the reducing sleeve cross brace **110**. The reducing sleeve cross brace **110** includes a first end and an opposing second end.

Each of the first and second ends of the brace **110** are coupled to the reducing sleeve **30**, for example, opposing sides of the inner wall of the reducing sleeve **30**. The exemplary turbine **20** can include multiple fixed runner vanes **140**, each extending out from an inner hub of the turbine **20**. In certain example embodiments, the runner vanes **140** are positioned equidistantly about an outer perimeter of the inner hub of the turbine **20**. It will be appreciated by one of ordinary skill in the art that multiple applications of the turbine **20** at various fixed runner vane **140** degrees may be applied based on the variation in fluid flow and pressure on a per application basis.

The foregoing outlines features of several embodiments so that those skilled in the art may better understand the aspects of the present disclosure. Those skilled in the art should appreciate that they may readily use the present disclosure as a basis for designing or modifying other processes and structures for carrying out the same purposes and/or achieving the same advantages of the embodiments introduced herein. Those skilled in the art should also realize that such equivalent constructions do not depart from the spirit and scope of the present disclosure, and that they may make various changes, substitutions and alterations herein without departing from the spirit and scope of the present disclosure.

Although only a few example embodiments have been described in detail above, those skilled in the art will readily appreciate that many modifications are possible in the example embodiments without materially departing from this disclosure. Accordingly, all such modifications are intended to be included within the scope of this disclosure as set forth in the following claims. In the claims, means-plus-function clauses are intended to cover the structures described herein as performing the recited function and not only structural equivalents, but also equivalent structures. Thus, although a nail and a screw may not be structural equivalents in that a nail employs a cylindrical surface to secure wooden parts together, whereas a screw employs a helical surface, in the environment of fastening wooden parts, a nail and a screw may be equivalent structures. It is the express intention of the applicant not to invoke 35 U.S.C. §112, paragraph 6 for any limitations of any of the claims herein, except for those in which the claim expressly uses the words 'means for' together with an associated function.

The Abstract at the end of this disclosure is provided to comply with 37 C.F.R. §1.72(b) to allow the reader to quickly ascertain the nature of the technical disclosure. It is submitted with the understanding that it will not be used to interpret or limit the scope or meaning of the claims.

What is claimed is:

**1**. A hydro energy system, comprising:

a pipe elbow comprising:

an inner wall defining a fluid carrying conduit;

a reducing sleeve removably coupled to the pipe elbow and disposed along at least a portion of the inner wall of the pipe elbow, wherein the reducing sleeve reduces a cross-sectional area for fluid flow in the fluid carrying conduit;

a turbine disposed in the fluid carrying conduit;

a drive shaft comprising a first end and a distal second end, wherein the turbine is coupled to the drive shaft between the first end and the second end and is configured to rotationally drive the drive shaft and wherein the second end of the drive shaft extends to an area outside an exterior wall of the pipe elbow; and

a generator disposed outside the exterior wall of the pipe elbow and coupled to the drive shaft adjacent the second end, wherein the generator generates electrical power in response to the rotational drive of the drive shaft by the turbine.



**2**. The hydro energy system of claim **1**, further comprising a flow diverter coupled to the reducing sleeve and disposed in the fluid carrying conduit upstream of the turbine.

**3**. The hydro energy system of claim **2**, wherein the flow diverter is a wicket gate flow diverter.

**4**. The hydro energy system of claim **1**, wherein the generator is directly coupled to the drive shaft adjacent the second end of the drive shaft.

**5**. The hydro energy system of claim **1**, further comprising a control unit communicably coupled to the generator, wherein the control unit is configured to regulate the electrical power generated by the generator.

**6**. The hydro energy system of claim **1**, further comprising a belt drive system, wherein the drive shaft is coupled to a first portion of the belt drive system adjacent the second end of the drive shaft and wherein the generator is coupled to a second portion of the belt drive system, wherein the belt drive system is configured to transfer the rotational drive of the drive shaft to the generator.

**7**. The hydro energy system of claim **1**, wherein the reducing sleeve further comprises a cross brace member coupled to the reducing sleeve and extending in a direction substantially orthogonal to a direction of fluid flow in the fluid carrying conduit, wherein the cross brace comprises a bearing sleeve, and wherein the drive shaft is coupled to the cross brace of the reducing sleeve adjacent the first end of the drive shaft.

**8**. The hydro energy system of claim **7**, wherein the cross brace member is twisted about a longitudinal axis of the cross brace member.

**9**. The hydro energy system of claim **7**, further comprising a flow diverter coupled to an inner wall of the reducing sleeve and disposed in the conduit upstream of the turbine, wherein the flow diverter comprises:

an inner hub;

a bearing sleeve defining a channel through the inner hub, wherein at least a portion of the drive shaft extends through the channel; and

a plurality of director vanes extending out from the inner hub in a plurality of directions.

**10**. A hydro energy system, comprising:

a turbine disposed in a fluid carrying conduit comprising a pipe elbow having an inner wall;

a reducing sleeve disposed along at least a portion of the inner wall of the fluid carrying conduit, the reducing sleeve reducing a cross-sectional area for fluid flow in the fluid carrying conduit;

a flow diverter disposed in the conduit upstream of the turbine;

a drive shaft coupled to and rotationally driven by the turbine, wherein the drive shaft comprises a first portion coupled to the turbine and a distal second portion extending outside of the conduit; and

a generator disposed outside of the conduit and operatively coupled to the drive shaft, wherein the generator generates electrical power in response to the rotational drive of the drive shaft by the turbine.

**11**. The hydro energy system of claim **10**, wherein the flow diverter is coupled to the reducing sleeve and comprises a wicket gate flow diverter comprising an inner hub, an aperture defining a passageway through the inner hub, wherein at least a portion of the drive shaft extends through the passageway, and a plurality of fixed director vanes extending out from the inner hub in a plurality of directions.

**12**. The hydro energy system of claim **10**, wherein the generator is operatively coupled to the drive shaft by a transmission system.

**13**. The hydro energy system of claim **10**, wherein the generator is directly coupled to the distal second portion of the drive shaft.

**14**. The hydro energy system of claim **10**, further comprising a control unit communicably coupled to the generator, wherein the control unit is configured to regulate the electrical power generated by the generator.

**15**. The hydro energy system of claim **10**, wherein the reducing sleeve is removably coupled to the fluid carrying conduit.

**16**. A hydro energy system, comprising:

a fluid carrying conduit comprising an inner wall defining a fluid passageway having a cross-sectional area;

a turbine disposed in the fluid carrying conduit;

a reducing sleeve coupled to the fluid carrying conduit and disposed along the inner wall of the fluid carrying conduit proximate the turbine, wherein the reducing sleeve reduces the cross-sectional area of the fluid passageway;

a drive shaft comprising a first portion and a distal second portion, wherein the first portion is coupled to and rotationally driven by the turbine, and wherein the second portion extends from the first portion to an area outside the conduit;

a cross brace member coupled to the reducing sleeve and extending in a direction substantially orthogonal to a direction of fluid flow in the fluid carrying conduit, wherein the cross brace comprises a bearing sleeve, wherein the drive shaft is disposed through the bearing sleeve of the cross brace, and wherein the cross brace member is twisted about a longitudinal axis of the cross brace member; and

a generator disposed outside the conduit and operatively connected to the drive shaft, wherein the generator generates electrical power in response to the rotational drive of the drive shaft by the turbine.

**17**. The hydro energy system of claim **16**, wherein the generator is directly coupled to the distal second portion of the drive shaft.

**18**. The hydro energy system of claim **16**, further comprising a control unit associated with and communicably coupled to the generator and configured to regulate the electrical power generated by the generator.

**19**. The hydro energy system of claim **16**, further comprising a flow diverter coupled to the reducing sleeve and disposed in the conduit upstream of the turbine, the flow diverter comprising an inner hub and a plurality of angularly disposed director vanes extending radially out from the inner hub.

**20**. The hydro energy system of claim **16**, wherein the fluid carrying conduit comprises a pipe elbow, wherein the reducing sleeve is coupled to the pipe elbow and disposed along the inner wall of the pipe elbow.

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